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(56) Documents Cited

GB 2207068 A	GB 2141519 A	GB 2102533 A
GB 2081026 A	EP 0265415 A	US 5253841 A

(58) Field of Search
UK CL (Edition O) F2A AD36 , F2S SAX SCB SCF
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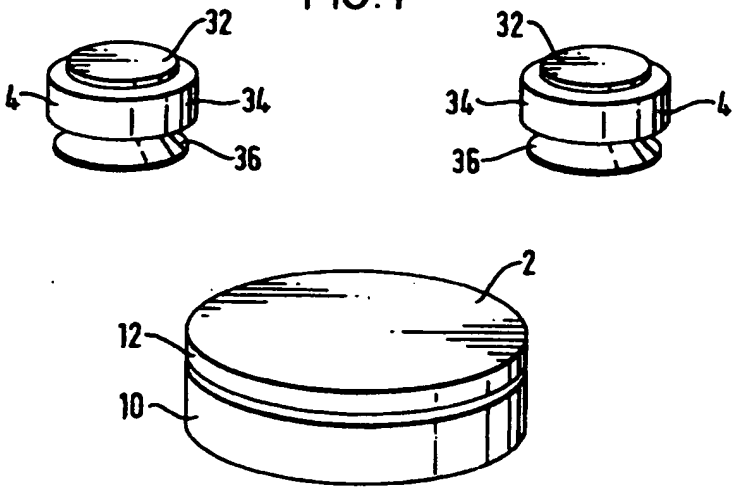
(54) **Support for vibrating apparatus**

(57) A support 2 for vibrating apparatus, e.g. a loudspeaker, comprises a base 10 and a supporting portion 12 mounted thereon by means of a low-friction bearing so that the supporting portion can vibrate in a horizontal direction with respect to the base. As shown, the bearing comprises co-operating grooves 18, 20 in the base and supporting portion respectively, containing ball bearings 14, 16, and limited by central stops 22, 24, and end stops 26, 28. The support is preferably located at the front of the loudspeaker (6), with two planar bearing supports (4, allowing movement in any direction in the horizontal plane) at the rear.

FIG. 1



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1995

FIG. 1

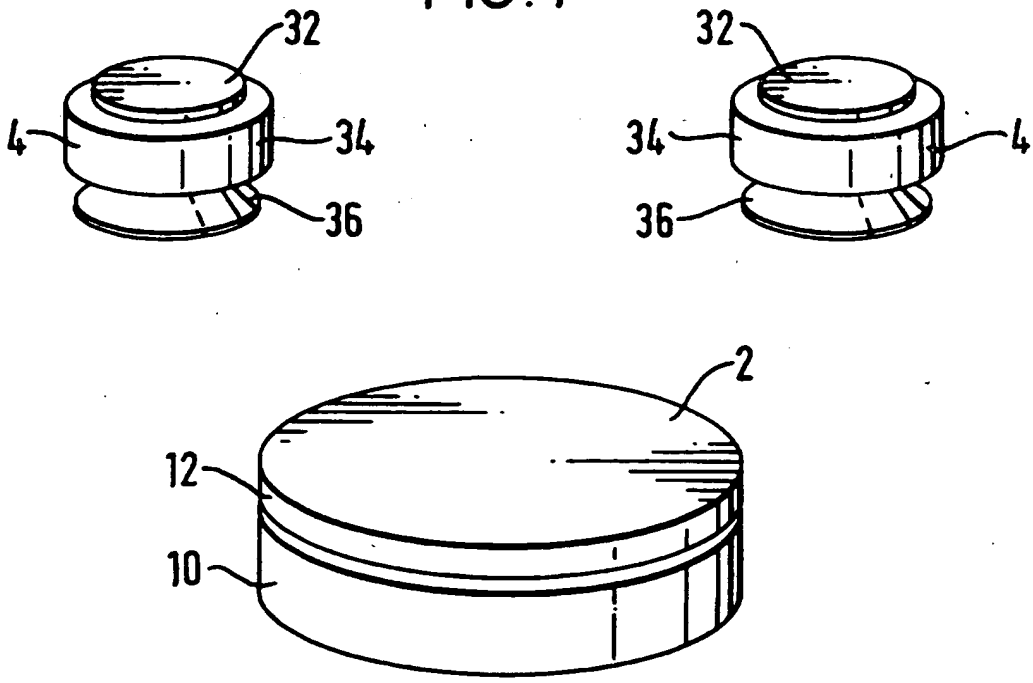
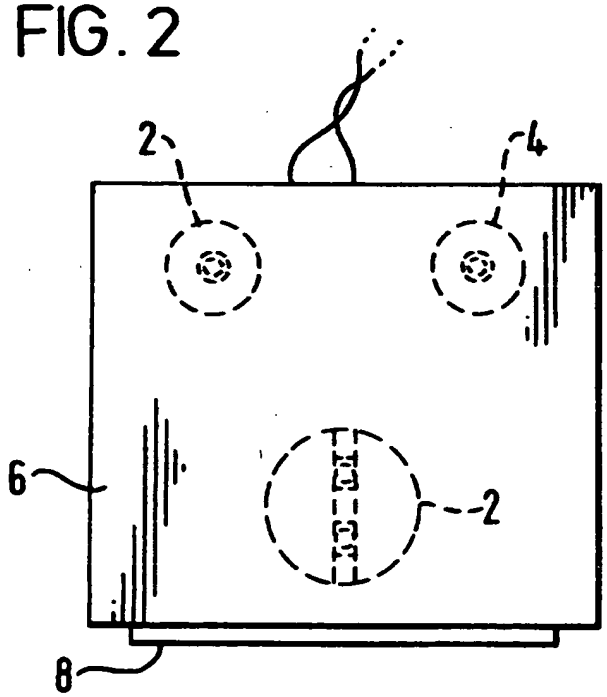


FIG. 2



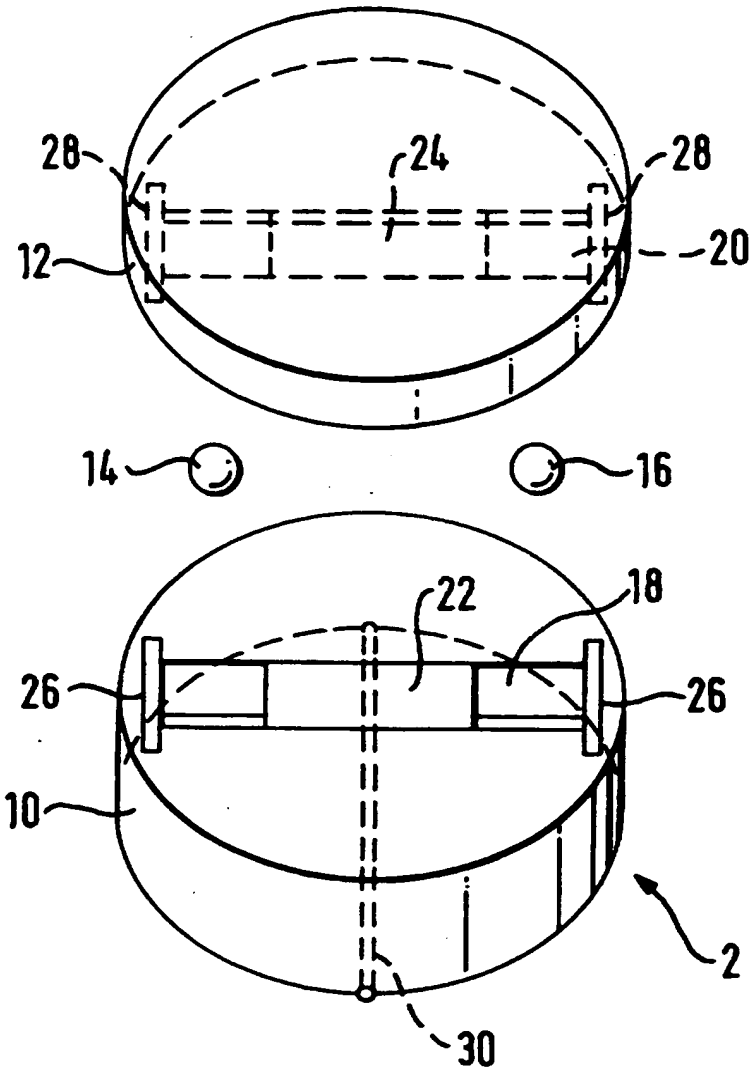


FIG. 3

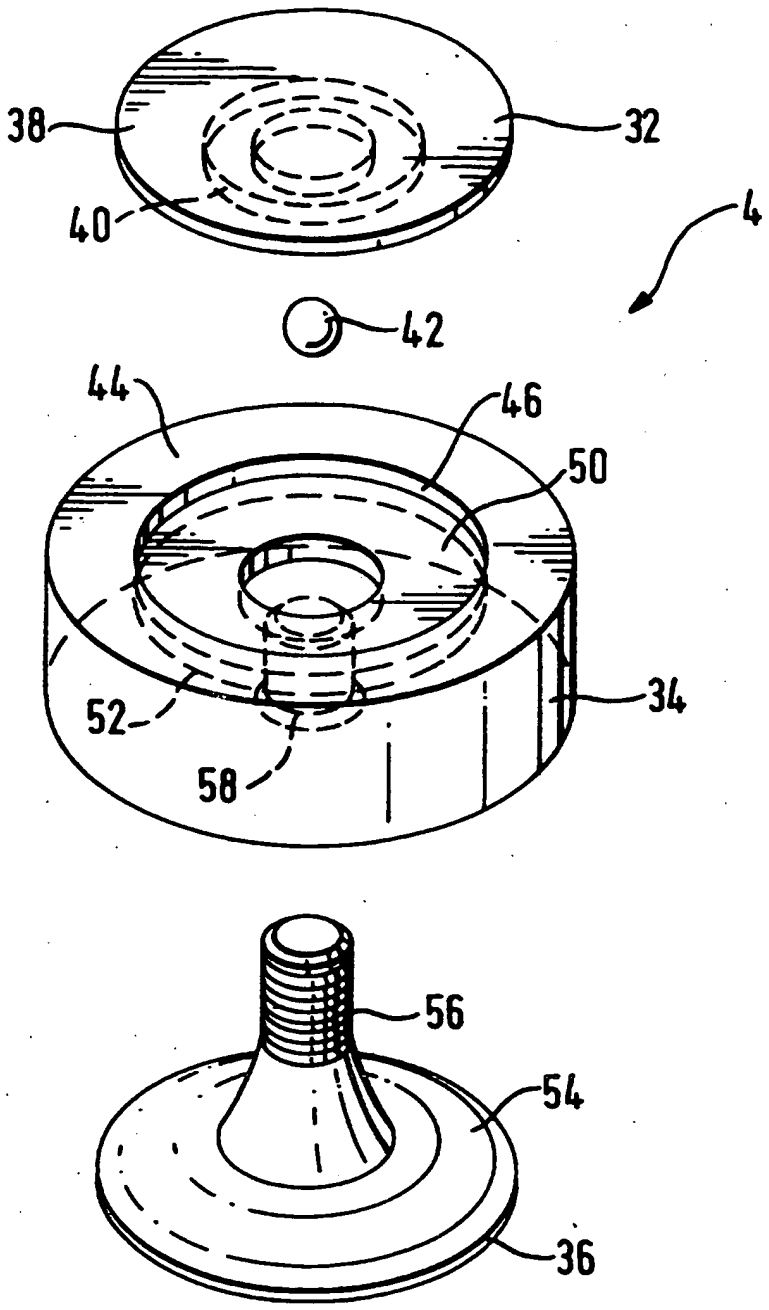


FIG. 4

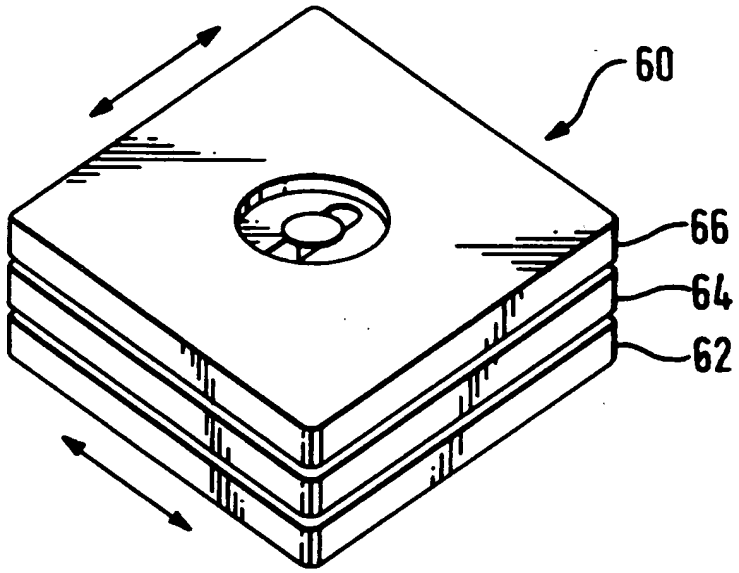


FIG. 5

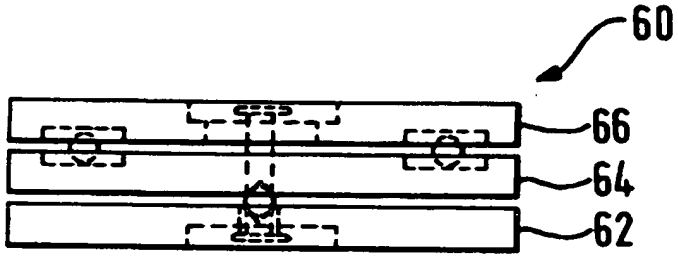
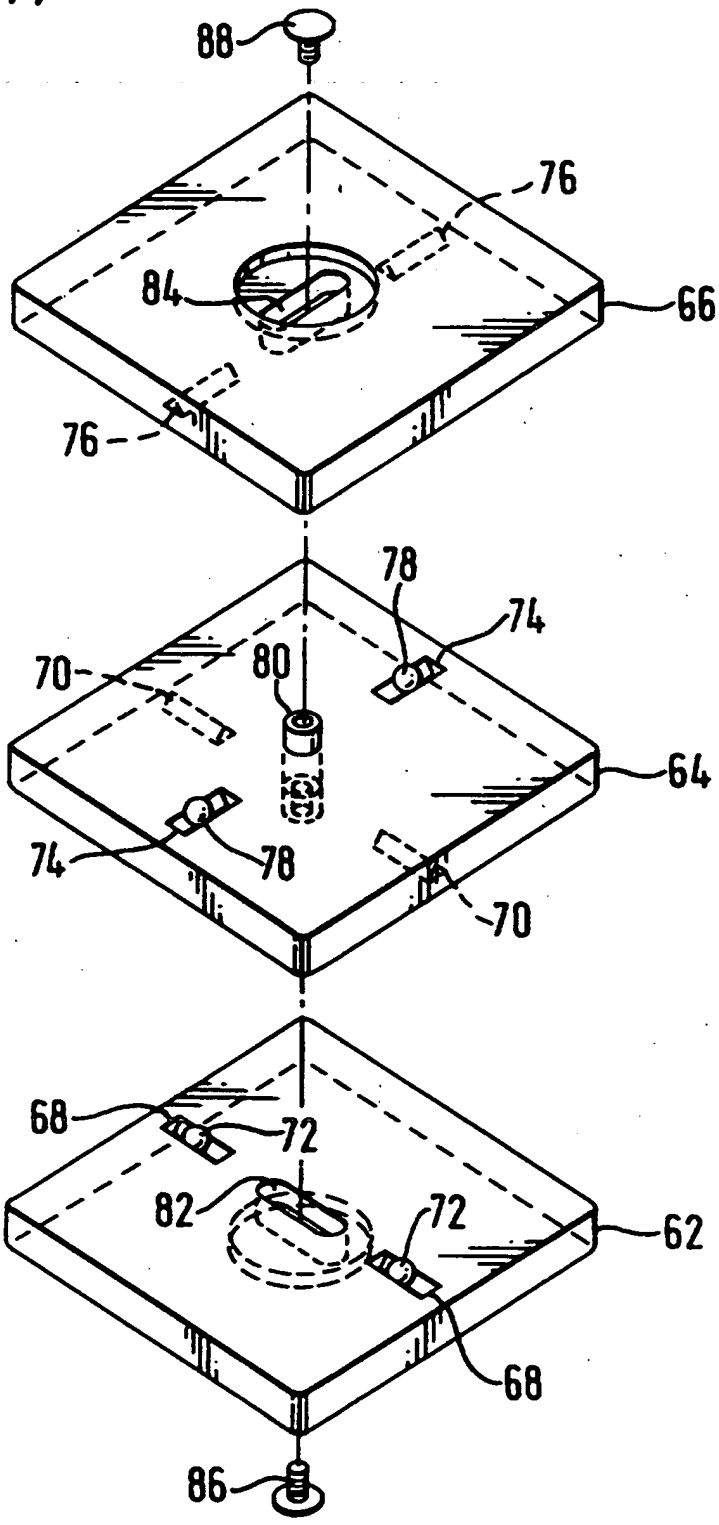


FIG. 6

FIG. 7



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A SUPPORT FOR VIBRATING APPARATUS

This invention relates to a support for vibrating apparatus. More particularly but not exclusively the invention relates to a set of supports for components of a hi-fi system, such as loudspeakers.

Until the present time, the loudspeakers of hi-fi systems have been mounted in various manners. To achieve a high quality of reproduction of sound it has conventionally been believed that loudspeakers should be mounted on stands which are relatively robust and solid. This provides for fidelity of reproduction insofar as the loudspeaker stands are used to cut out undesirable resonant vibrations which are set up in the loudspeaker including its housing.

However, one drawback of known supports for loudspeakers is that, however a loudspeaker is mounted, the support will transmit vibrations from the loudspeaker itself into the surrounding materials. Thus, sound vibrations are transmitted to the floor, walls and ceiling of a room in which a hi-fi system is being played. The floor, walls and ceilings of a room generally have resonant frequencies of 20-80 Hz and vibrations at their resonant frequencies will be amplified in the room.

There are various problems associated with the transmission of vibrations from audio equipment via its supports. Sound travels faster in solid materials than the atmosphere, and takes circuitous routes when transmitted via solid materials between the loudspeakers and the ear of the listener. Sound vibrations created by a speaker and transmitted via solid matter can audibly interfere with the sound created by the loudspeaker and transmitted directly by

the atmosphere. This naturally results in a lower fidelity of reproduction.

Furthermore, vibrations set up in solid material on which audio equipment is mounted can cause distortion of the output from the equipment because of the effects of the vibrations within the equipment. The performance of loudspeakers themselves can be interfered with by resonant and other vibrations which can cause the loudspeaker output to be degraded.

Some approaches to dealing with the transmission of unwanted vibrations are not considered workable. The vibrations occurring in material around speakers and other audio equipment cannot be properly suppressed simply by adding weight to an apparatus. It has also been found that, although flexible supports such as rubber or air suspension can reduce the transmission of vibrations from a loudspeaker to the surrounding solid environment, such a flexible mounting provides a speaker with excessive freedom of vibration. Vibrational degrees of freedom are provided in the form of three linear movements along the x, y and z axes and the three rotational modes of vibration around each of these three axes. Interference between vibrations operating in these six degrees of freedom produces further vibrational modes. As a result, flexible mountings allow a loudspeaker and its housing to resonate at a large number of resonant frequencies and the performance of the loudspeaker is degraded.

It would be desirable to provide a support for audio equipment which, whilst inhibiting resonance of the audio equipment itself, also inhibits the transmission of vibrations into the surrounding materials via the support.

According to an aspect of the present invention,

there is provided a support for vibrating apparatus, said support comprising a base and a supporting portion mounted on the base by a low friction bearing for allowing the supporting portion to vibrate in a substantially horizontal direction with respect to the base.

Preferably, the low friction bearing is relatively rigid in the vertical direction to inhibit vertical vibration of the apparatus, when mounted on the support, with respect to the base.

According to a further aspect of the invention, there is provided a support for vibrating apparatus, the support being so formed as to provide a limited number of degrees of freedom of movement so that vibration in said degrees of freedom are not transmitted through the support.

By providing the vibrating apparatus, which may for example be audio equipment, with a limited freedom of movement, via a low-friction bearing in a predetermined direction or directions, the transmission of vibrations from the vibrating apparatus to the surrounding environment via the base is inhibited. Resonance of the vibrating apparatus housing is also inhibited.

Preferably, the bearing comprises one or more ball bearings which are constrained between the supporting portion and the base by guide means or flange means.

In certain embodiments of the invention, the guide means or flange means preferably contain the one or more ball bearings to move in a linear direction.

In an embodiment which is suitable for audio equipment, the low-friction bearing support allows substantially linear movement along one axis or along two substantially perpendicular directions only. A

support comprising a bearing allowing linear motion only can be so aligned when supporting a loudspeaker as to allow free vibration of the loudspeaker in the direction in which the loudspeaker diaphragm is vibrated by the input signals (i.e. forwards and backwards). When the support is so aligned the greatest part of the vibrations of the loudspeaker are isolated from the surrounding environment.

Preferably the support utilises a point-like contact or thin line of contact between hard surfaces to support the weight of the equipment, reducing the transmission of vibrations. The point-like contact may be provided by ball bearings, metal rods or other means which are capable of supporting at a point, or along a thin line, of contact.

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying diagrams, wherein:-

Fig. 1 is a perspective view of a set of supports embodying the present invention;

Fig. 2 is a plan view of a portion of a loudspeaker supported by the set of supports illustrated in Fig. 1;

Fig. 3 is an exploded perspective view of one of the supports shown in Fig. 1; and

Fig. 4 is an exploded perspective view of another of the supports illustrated in Fig. 1.

Fig. 5 is a perspective view of a support according to a further embodiment of the invention;

Fig. 6 is a side view of the support shown in Fig. 5; and

Fig. 7 is an exploded perspective view of the support shown in Figs. 5 and 6.

Referring to Fig. 1, a set of supports embodying the invention comprises a linear bearing support 2

(which allows low-friction motion in a linear horizontal direction only) and two planar bearing supports 4 (which allow motion in any direction in a horizontal plane). The supports can be arranged in various manners in order to provide support to audio equipment as required. There is however a preferred manner of arrangement in which the supports are arranged relative to one another as shown in Fig. 2. A loudspeaker 6 is placed upon the supports 2 and 4 when they are arranged in a triangular array, with the linear bearing support 2 supporting the front 8 of the loudspeaker and the planar bearing supports 4 supporting the rear of the loudspeaker.

In order to understand the construction of the supports, reference should be made to Figs. 3 and 4.

Consider first the linear bearing support 2 which has a circular wooden or steel base 10 and a circular wooden or steel top 12. Two ball bearings 14 and 16 are borne between the base 10 and the top 12. The ball bearings may typically have a diameter of 7mm, although ball bearings of any suitable diameter may of course be used. The ball bearings 14 and 16 move along a linear path defined by triangular grooves 18 and 20 in the base and top respectively. Whereas the body of the base and top may be formed of wood, steel or other rigid material, groove 18 is preferably defined by a metal such as steel. Groove 20 is also similarly defined. It is to be said that other relatively hard materials could instead be used. The ball bearings 14 and 16 are constrained to travel only short distances within the grooves 18 and 20 by means of central stops 22 and 24 located in the middle of the grooves, and end stops 26 and 28 located at the ends of the grooves. The ball bearings 14 and 16 are thus located towards the outer periphery of the

support 2 to provide even balance in use.

A metal rod 30 of small diameter is located in a shallow groove on the lower surface of the base 10, such that when the base is level (as it should be in use), the metal rod 30 fully supports the base when placed on a flat horizontal surface. The rod 30 may typically have a diameter of 2mm although of course a rod of any suitable diameter may be used. The rod 30 is disposed at right angles to the groove 18.

With regard to Fig. 4, each of the planar bearing supports 4 comprise a top 32, a middle portion 34 and a base 36. The top 32 consists of a circular metal disc 38 and a metal annular ring 40 bonded concentrically to the base of the disc 38. The annular ring 40 therefore defines a circular flange against which a ball bearing 42, held between the top 32 and the middle portion 34, abuts.

The middle portion consists of a circular body 44 which may be made of wood or steel and has a cylindrical hollow 46 on its upper surface. A metal annular ring 50 is located within the hollow 46. A metal plate 52 is located beneath the annular ring 50. Thus, a lower circular flange against which the ball bearing 42 abuts is defined by the annular ring 50. When the support is assembled and in use, the ball bearing 42 bears the entire weight above it and is contacted above and below by metal plates 38 and 52. This is advantageous in that it provides for low frictional resistance in the bearing. Although in the illustrated embodiment only one ball bearing 42 is used in each support 4, more than one ball bearing could equally well be used.

The base 36 has a circular foot 54 and an upstanding threaded member 56 which threadingly engages with a bore 58 located on the underside of the

middle portion 34. The height of the support 4 is adjustable by rotation of the middle portion 34 with respect to the box 36.

When assembled, the supports appear as shown in Fig. 1. Furthermore, when used to support a speaker, the grooves 18 and 20 are aligned as illustrated in Fig. 2 to allow the loudspeaker a freedom of movement which is parallel to the direction of vibration of the loudspeaker membrane (hereinafter referred to as the x-axis). Because the ball bearings 14 and 16 in the grooves 18 and 20 and the ball bearings 42 of the supports 4 in the annular rings 40 and 50 offer a low-friction motion, the loudspeaker is almost entirely free to move along the x-axis, i.e. backwards and forwards. This movement is of course within the constraints of the length of the groove portions in which the ball bearings 14 and 16 move and the diameter of the inner flanges of the rings 40 and 50.

When the loudspeaker 6 is used to reproduce an input signal, the greatest part of the x-axis vibrations produced by the loudspeaker are isolated by the supports 2 and 4 and are not transmitted from the loudspeaker 6 via the supports 2 and 4 to the floor or other surface on which the loudspeaker is mounted. The use of ball bearings within the support reduces the contact between the upper and lower portions substantially to a point, which further reduces the scope for transmission of horizontal vibrations between the loudspeaker 6 and its surroundings. Similarly the rod 30 reduces the transmission and rotational vibrations in the direction of the x-axis by providing a rotational degree of freedom about an axis substantially horizontal and perpendicular to the x-axis (hereinafter referred to as the y-axis). At the same time, vibration of the loudspeaker along and

about other axes is inhibited because there is no freedom of movement along or about any other axis. As a result, the supports 2,4 inhibit a large amount of the resonance which would otherwise occur at various frequencies within the loudspeaker housing.

It is to be noted that the bearing supports need not be constrained to move only linearly. An arrangement which allows low-friction motion along both the x-axis and the y-axis may be employed. Thus, a third embodiment of support as illustrated in Figs. 5-7 might be utilised. The support illustrated will be referred to herein as an x, y bearing support 60. The x, y bearing support consists of a lower steel plate 62, a middle steel plate 64 and an upper steel plate 66. Middle plate 64 is mounted above lower plate 62 in a similar fashion to the mounting of top 12 with respective base 10 of the embodiment shown in Figs. 1-3. The middle plate is free to move in the x direction. Triangular grooves 68 are formed coaxially along a line disposed parallel to the x axis in the upper surface of lower plate 62, and corresponding triangular grooves 70 are formed in the lower surface of middle plate 64. Steel ball bearings 72 roll freely within grooves 68 and 70. Furthermore, top plate 66 is free to move in the y direction with respect to middle plate 64 by means of a similar mounting. Triangular grooves 74 are formed coaxially along a line parallel to the y axis in the upper surface of middle plate 64. Corresponding triangular grooves 76 are formed in the lower surface of upper plate 66. Ball bearings 78 move freely within grooves 74 and 76.

A retaining shaft 80 is fixed in the centre of middle plate 64, protruding from both its upper and lower surfaces. A threaded bore is formed in each end

of the retaining shaft. An elongate aperture 82 is formed in lower plate 62 extending coaxially with grooves 68 and parallel to the x axis. Similarly, an elongate aperture 84 is formed in the upper plate 66, coaxially with grooves 76 and extending in a direction parallel to the y axis. When assembled, a screw 86 extends through the aperture 82 and engages with retaining shaft 80. Aperture 82 is sufficiently wide to allow middle plate 64 to move freely with respect to lower plate 62, whilst keeping the two plates together. Similarly, a retaining screw 88 passes through aperture 84 and engages with the bore formed in the other end of the retaining shaft 80 to loosely attach the upper plate 66 to the middle plate 64. For aesthetic purposes, the aperture 84 may be covered by a cap (not shown).

The x, y bearing support 60 enables vibrations of equipment supported on the support to be isolated from the supporting surfaces. The bearing formed between the upper plate 66 and the middle plate 64 isolates the resolved components of vibrations occurring parallel to the y axis from the supporting surfaces, whereas the x-axis resolved components of vibrations are individually isolated by the bearing formed between the middle plate 64 and the lower plate 62. As will be appreciated from the foregoing, vertical components of vibrations on the other hand will be freely transmitted through the support 60

Bearings allowing vibrations having components parallel both to the x axis and to the y axis in a horizontal direction could also be isolated by different arrangements to that described in relation to Figs. 5-7, which show a non-limiting embodiment. To that end two sets of the bearing supports 2 and 4 already described may be used, stacked one above the

other with the linear bearing supports 2 rotated 90° with respect to each other. A set of supports consisting of the planar bearings 4 may instead be utilised. Bearings which constrain the movement of the supported equipment to be along a curved but substantially horizontal surface would also achieve similar advantages.

For audio equipment other than loudspeakers, such as turntables which have rotational movement, the vibrations naturally set up within the equipment during operation may mainly occur in various horizontal directions. In these, and other cases, supports as described which allow low-friction motion in both the x-direction (backwards and forwards) and the y-direction (side to side) could be advantageously utilised. Other equipment which could benefit from the use of supports according to the present invention include CD players, televisions and other audio, or audio-visual equipment. In fact, any electronic equipment which produces undesirable vibrations could benefit from the use of supports embodying the invention.

Furthermore, it will be appreciated by a person skilled in the art that various modifications and variations could be employed without departing from the spirit or extending the scope of the invention.

CLAIMS:

1. A support for vibrating apparatus, said support comprising a base and a supporting portion mounted on the base by a low friction bearing for allowing the supporting portion to vibrate in a substantially horizontal direction with respect to the base.

2. A support according to claim 1, wherein the low friction bearing is relatively rigid in a substantially vertical direction (compared to the said substantially horizontal direction) to inhibit vertical vibration of the supporting portion with respect to the base.

3. A support according to claim 1 or 2, the low-friction bearing support allows substantially linear movement along one axis or in a substantially horizontal plane only.

4. A support according to claim 1, 2 or 3, wherein the low-friction bearing utilises a point-like contact or thin line of contact between hard surfaces to support the apparatus.

5. A support according to claim 4, wherein the point-like contact is provided by ball bearings, metal rods or other means which are capable of supporting at a point, or along a thin line, of contact.

6. A support according to claim 5, wherein the low-friction bearing comprises one or more ball bearings which are constrained between the supporting portion and the base by guide means or flange means.

7. Audio equipment comprising a support according to any of claims 1 to 6.

8. A loudspeaker according to claim 7.

9. A method of supporting audio equipment, comprising supporting the equipment to provide one or more, but a limited number of, degrees of freedom of movement so that vibrations in said degrees of freedom are substantially not transmitted through the support.

10. A method according to claim 9, wherein said degrees of freedom are in substantially horizontal directions only.

11. A method according to claim 9 or 10, wherein the equipment is free to move in a linear direction only.

12. A support substantially as hereinbefore described in particular with reference to the accompanying drawings.

13. A method of supporting audio equipment substantially as hereinbefore described, in particular with reference to the accompanying drawings.

The Patent Office

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Application No: GB 9522691.6 **Examiner:** Ian Philpot
Claims searched: 11 **Date of search:** 7 June 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F2S (SAX, SCB, SCF); F2A (AD36)

Int Cl (Ed.6): F16F (15/00, 15/02)

Other: Online WPI (Questel)

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2207068 A	(SOMEX) See figure 1.	1-6.
X	GB 2141519 A	(STAAR) See fig. 3.	1, 7.
X	GB 2102533 A	(MARCONI) See figs 1, 2.	1.
X	GB 2081026 A	(POPPER ENGINEERING) See figure.	1-3.
X	EP 0265415 A	(ALFIT) See fig. 1	1-5, 7.
X	US 5253841 A	(SAMRA SUPPLY) See figures 1, 3 and col 2 lines 38-46	1-5.

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.